Claims

1. A method for recovering a volume of hydrocarbon from a location in a submarine or subterranean reservoir comprising:

conducting an electromagnetic survey of the reservoir, the survey method comprising

(a) deploying an electric dipole transmitter;

(b) deploying an electric dipole receiver;

(c) applying an electromagnetic (EM) field to the strata using the transmitter;

(d) detecting the EM wave field response using the receiver;

(e) extracting phase information from the wave response;

(f) repeating procedures (a) through (e) with the transmitter and/or receiver in different locations for a plurality of transmissions; and

(g) using the phase information from the wave response for the plurality of transmissions, in order to determine the presence and/or nature of the reservoir by analyzing the detected wavefield for the presence of a refracted wave component;

wherein the transmitter is operated at a transmission frequency in the range of 0.01 Hz to 1 kHz for the plurality of transmissions;

using the electromagnetic survey to determine that a volume of hydrocarbon is present at a location in the reservoir; and

producing the volume of hydrocarbon from a well that penetrates the reservoir near the location in the reservoir.

2. The method of claim 1, wherein procedure (d) is repeated at a plurality of different offsets between the transmitter and the receiver.

3. The method of claim 2, further comprising plotting a graph of the phase of a refracted wave response from a particular stratum associated with the reservoir against the offset between the transmitter and the receiver, and analyzing the slope of the graph to determine the nature of the stratum.

4. The method of claim 2, further comprising plotting a graph of the phase of the reflected wave response from a particular stratum associated with the reservoir against the offset between the transmitter and the receiver, and identifying a change in the slope of the graph.

5. The method of claim 1, further comprising extracting and using amplitude information from the refracted wave response.

6. The method of claim 1, wherein the transmitter and/or receiver is located on or close to the seabed or the bed of some other area of water.

7. The method of claim 1, wherein the field is transmitted for a period of time between 3 seconds and 60 minutes.

8. The method of claim 1, wherein the wavelength of the transmission is given by the formula

$$0.1s \leq \lambda \leq 10s;$$

wherein λ is the wavelength of the transmission through the overburden and s is the distance from the seabed to the reservoir.

9. The method of claim 1, in which an offset between the transmitter and the receiver is given by the formula:

$$0.5\lambda \leq L \leq 10\lambda;$$

where λ is the wavelength of the transmission through the overburden and L is the distance between the transmitter and the receiver.

10. The method of claim 1, wherein the transmitter is operated at a transmission frequency in the range from 0.1 to 20 Hz.

11. The method of claim 1, further comprising first performing a seismic survey to determine the geological structure of a region.

12. The method of claim 2, wherein the different offsets are greater than a critical offset between the transmitter and the receiver.

13. The method of claim 1, further comprising providing a member of the group consisting of the receiver, the transmitter, the receiver antenna, the transmitter antenna, and a combination thereof.

14. The method of claim 1, further comprising equipping a vessel with a member of the group consisting of the receiver, the transmitter, the receiver antenna, the transmitter antenna, and a combination thereof.

15. The method of claim 2, wherein the different offsets are at least three times greater than a thickness of the overburden for the reservoir.

16. A method of preparing a survey of a volume of hydrocarbon in a submarine or subterranean reservoir comprising:

conducting an electromagnetic survey of the reservoir, the survey method comprising

(a) deploying at least one electric dipole transmitter;

(b) deploying at least one electric dipole receiver;

(c) applying an electromagnetic (EM) field to the strata using the transmitter;

(d) detecting the EM wave field response using the receiver;

(e) extracting phase information from the wave response;

(f) repeating procedures (a) through (e) with the transmitter and/or receiver in different locations for a plurality of transmissions; and

(g) using the phase information from the wave response for the plurality of transmissions, in order to determine the presence and/or nature of the reservoir by analyzing the detected wavefield for the presence of a refracted wave component;

wherein the transmitter is operated at a transmission frequency in the range of 0.01 Hz to 1 kHz for the plurality of transmissions;

using the electromagnetic survey to determine that a volume of hydrocarbon is present in the reservoir; and

preparing a survey that graphically depicts a location of the volume of hydrocarbon in the reservoir.

17. The method of claim 16, wherein procedure (d) is repeated at a plurality of different offsets between the transmitter(s) and the receiver(s).

18. The method of claim 16, wherein the survey is depicted as a graph.

19. The method of claim 18, wherein the graph depicts a plot of the phase of a refracted wave response from a particular stratum associated with the reservoir against an offset between the transmitter(s) and the receiver(s).

20. The method of claim 18, wherein the graph depicts a plot of the phase of the reflected wave response from a particular stratum associated with the reservoir against an offset between the transmitter(s) and the receiver(s).

21. The method of claim 16, further comprising extracting and using amplitude information from the refracted wave response.

22. The method of claim 16, wherein the transmitter and/or receiver is located on or close to the seabed or the bed of some other area of water.

23. The method of claim 16, wherein the wavelength of the transmission is given by the formula

$$0.1s \leq \lambda \leq 10s;$$

wherein λ is the wavelength of the transmission through the overburden and s is the distance from the seabed to the reservoir.

24. The method of claim 16, in which a predetermined offset between the transmitter and a receiver is given by the formula:

$$0.5\lambda \leq L \leq 10\lambda;$$

where λ is the wavelength of the transmission through the overburden and L is the distance between the transmitter and the receiver.

25. The method of claim 16, wherein the transmitter is operated at a transmission frequency in the range from 0.1 to 20 Hz.

26. The method of claim 16, further comprising first performing a seismic survey to determine the geological structure of a region.

27. The method of claim 17, wherein the different offsets are greater than a critical offset between the transmitter(s) and the receiver(s).

28. The method of claim 17, wherein the different offsets are at least three times greater than a thickness of the overburden for the reservoir.